10/590245
IAP9 Rec'd PCT/PTO 22 AUG 2006

English Translation of Claims as added
Under Article 34 PCT

CLAIMS

1. (amended) An encoding device characterized by comprising:

two-dimensional Haar wavelet transforming means for dividing a two-dimensional signal into subbands as a plurality of frequency regions;

coefficient extracting means for, whenever said two-dimensional Haar wavelet transforming means transforms a predetermined number of two-dimensional signals into a predetermined number of coefficients, extracting sets of AC-component coefficients of coefficients obtained by transform, for every predetermined number of sets of coefficients which belong to the same spatial position;

coefficient encoding means for encoding and concatenating the extracted AC-component coefficient sets, and generating a code sequence of a high-frequency subband;

initial coefficient encoding means for encoding and concatenating a DC component as a lowest-frequency subband, and generating the code sequence of the lowest-frequency subband; and

code output means for outputting the code sequence of the lowest-frequency subband, and sequentially outputting the code sequence of the high-frequency subband generated by said coefficient encoding means.

2. An encoding device according to claim 1, characterized in that said coefficient extracting means sequentially extracts a predetermined number of coefficient sets at a time in a scan line direction of the two-dimensional signal.

4. (amended) An encoding device characterized by comprising:

element extracting means for sequentially extracting $2m \times 2$ (m is an integer: $m \geq 1$) spatially adjacent elements from a two-dimensional signal;

two-dimensional Haar wavelet transforming means for dividing the $2m \times 2$ elements into a plurality of subband coefficient sets;

coefficient encoding means for encoding and concatenating the AC-component coefficient sets obtained by transform by said two-dimensional Haar wavelet transforming means, and generating a code sequence of a high-frequency subband;

initial coefficient encoding means for encoding and concatenating a DC component as a lowest-frequency subband, and generating the code sequence of the lowest-frequency subband; and

code output means for outputting the code sequence of the lowest-frequency subband, and sequentially outputting the code sequence of the high-frequency subband generated by said coefficient encoding means.

5. An encoding device according to claim 1, characterized in that

each coefficient comprises a plurality of components, and

said coefficient encoding means encodes each component of a coefficient, and generates a code by concatenating a code of each component below each coefficient.

6. An encoding device according to claim 4, characterized in that

each coefficient comprises a plurality of components, and

said coefficient encoding means encodes each component of a coefficient, and generates a code by concatenating a code of each component below each coefficient.

7. An encoding device according to claim 1, characterized in that

each coefficient comprises a plurality of components, and

said coefficient encoding means encodes each component of a coefficient, and generates a code by concatenating a code of each coefficient below each component.

8. An encoding device according to claim 4, characterized in that

each coefficient comprises a plurality of components, and

said coefficient encoding means encodes each component of a coefficient, and generates a code by concatenating a code of each coefficient below each component.

9. (deleted)

10. (deleted)

11. (deleted)

12. (deleted)

13. (deleted)

14. (deleted)

15. (deleted)

16. (deleted)

17. (deleted)

18. (deleted)

19. (deleted)

20. (deleted)

21. (deleted)

22. (amended) An encoding device according to claim 1, characterized by further comprising

coefficient thinning map generating means for generating a coefficient thinning map in which resolution at each spatial coordinate of the two-dimensional signal is set, and

updated region detecting means for detecting a updated region from a plurality of sequential frames of a sequence of a plurality of frames forming the two-dimensional signal, and obtaining a changing period during which a signal value changes in each partial region from said plurality of sequential frames,

wherein said coefficient thinning map generating means sets the resolution on the basis of the changing period, and generates a coefficient thinning map in which resolution of the updated region differs from resolution of a region other than the updated region, and

said coefficient extracting means refers to the coefficient thinning map, and extracts coefficients by thinning the coefficients to the resolution set for the coordinate.

23. (amended) An encoding device according to claim 4, characterized by further comprising

coefficient thinning map generating means for generating a coefficient thinning map in which resolution at each spatial coordinate of the two-dimensional signal is set, and

updated region detecting means for detecting a updated region from a plurality of sequential frames of a sequence of a plurality of frames forming the two-dimensional signal, and obtaining a changing period during which a signal value changes in each partial region from said plurality of sequential frames,

wherein said coefficient thinning map generating means sets the resolution on the basis of the changing period, and generates a coefficient

thinning map in which resolution of the updated region differs from resolution of a region other than the updated region, and

said element extracting means refers to the coefficient thinning map, and extracts coefficients by thinning the coefficients to the resolution set for the coordinate.

24. An encoding device according to claim 22, characterized in that said coefficient thinning map generating means sets low resolution in a region in which the changing period is long.

25. An encoding device according to claim 23, characterized in that said coefficient thinning map generating means sets low resolution in a region in which the changing period is long.

26. (deleted)

27. (deleted)

28. (deleted)

29. (deleted)

30. (deleted)

31. (deleted)

32. (deleted)

33. (deleted)

34. (deleted)

35. (deleted)

36. (deleted)

37. (deleted)

38. (amended) An encoding device according to claim 1, characterized by further comprising

coefficient quantization map generating means for generating a coefficient quantization map in which quantization accuracy at each spatial coordinate of the two-dimensional signal is set,

coefficient quantizing means for quantizing a coefficient to quantization accuracy corresponding to a spatial coordinate of the coefficient by referring to the coefficient quantization map, and

updated region detecting means for detecting a updated region from a plurality of sequential frames of a sequence of a plurality of frames forming the two-dimensional signal, and obtaining a changing period during which a signal value changes in each partial region from said plurality of sequential frames,

wherein said coefficient quantization map generating means sets the quantization accuracy on the basis of the changing period, and generates a coefficient quantization map in which quantization accuracy of the updated region differs from resolution of a region other than the updated region, and

said coefficient encoding means encodes a set of the quantized coefficients.

39. (amended) An encoding device according to claim 4, characterized by further comprising

coefficient quantization map generating means for generating a coefficient quantization map in which quantization accuracy corresponding to each spatial coordinate of the two-dimensional signal is set,

coefficient quantizing means for quantizing a coefficient set to quantization accuracy corresponding to a spatial coordinate of the coefficient set by referring to the coefficient quantization map, and

updated region detecting means for detecting a updated region from a plurality of sequential frames of a sequence of a plurality of frames

forming the two-dimensional signal, and obtaining a changing period during which a signal value changes in each partial region from said plurality of sequential frames,

wherein said coefficient quantization map generating means sets the quantization accuracy on the basis of the changing period, and generates a coefficient quantization map in which quantization accuracy of the updated region differs from resolution of a region other than the updated region, and

said coefficient encoding means encodes a set of the quantized coefficients.

40. An encoding device according to claim 38, characterized in that said coefficient thinning map generating means sets low quantization accuracy in a region in which the changing period is long.

41. An encoding device according to claim 39, characterized in that said coefficient thinning map generating means sets low quantization accuracy in a region in which the changing period is long.

42. (deleted)

43. (deleted)

44. (deleted)

45. (deleted)

46. (amended) An encoding device according to claim 1, characterized by further comprising

coefficient thinning map generating means for generating a coefficient thinning map in which resolution at each spatial coordinate of the two-dimensional signal is set, and

updated region detecting means for detecting, as a updated region, an overlapping region of a region to be encoded of a preceding frame

and a region to be encoded of a succeeding frame of a sequence of a plurality of frames forming the two-dimensional signal,

wherein said coefficient thinning map generating means generates a coefficient thinning map in which resolution of the updated region differs from resolution of a region other than the updated region, and

said coefficient extracting means refers to the coefficient thinning map, and extracts coefficients by thinning the coefficients to the resolution set for the coordinate.

47. (amended) An encoding device according to claim 4, characterized by further comprising

coefficient thinning map generating means for generating a coefficient thinning map in which resolution at each spatial coordinate of the two-dimensional signal is set, and

updated region detecting means for detecting, as a updated region, an overlapping region of a region to be encoded of a preceding frame and a region to be encoded of a succeeding frame of a sequence of a plurality of frames forming the two-dimensional signal,

wherein said coefficient thinning map generating means generates a coefficient thinning map in which resolution of the updated region differs from resolution of a region other than the updated region, and

said element extracting means refers to the coefficient thinning map, and extracts coefficients by thinning the coefficients to the resolution set for the coordinate.

48. (amended) An encoding device according to claim 1, characterized by further comprising

coefficient quantization map generating means for generating a coefficient quantization map which represents quantization accuracy at each

spatial coordinate of the two-dimensional signal, coefficient quantizing means for quantizing coefficients to quantization accuracy corresponding to each spatial coordinate of the coordinates with reference to the coefficient quantization map, and

updated region detecting means for detecting, as a updated region, an overlapping region of a region to be encoded of a preceding frame and a region to be encoded of a succeeding frame of a sequence of a plurality of frames forming the two-dimensional signal,

wherein said coefficient thinning map generating means generates a coefficient quantization map in which quantization accuracy of the updated region differs from quantization accuracy of a region other than the updated region, and

said coefficient encoding means encodes a set of the quantized coefficients.

49. (amended) An encoding device according to claim 4, characterized by further comprising

coefficient quantization map generating means for generating a coefficient quantization map in which quantization accuracy corresponding to each spatial coordinate of the two-dimensional signal is set,

coefficient quantizing means for quantizing a coefficient set to quantization accuracy corresponding to a spatial coordinate of the coefficient set by referring to the coefficient quantization map, and

updated region detecting means for detecting, as a updated region, an overlapping region of a region to be encoded of a preceding frame and a region to be encoded of a succeeding frame of a sequence of a plurality of frames forming the two-dimensional signal,

wherein said coefficient quantization map generating means generates a coefficient quantization map in which quantization accuracy of the updated region differs from quantization accuracy of a region other than the updated region, and

said coefficient encoding means encodes a set of the quantized coefficients.

50. (amended) A decoding device which sequentially receives coefficients of a plurality of subbands obtained by two-dimensional Haar wavelet transform as a code sequence of the subband, from a code sequence of a lowest-frequency subband to a code sequence of a high--frequency subband, characterized by comprising:

initial coefficient decoding means for decoding a coefficient of the lowest-frequency subband from a code sequence corresponding to the lowest-frequency subband, and generating a two-dimensional signal of the lowest-frequency subband;

coefficient decoding means for decoding sets of AC-component coefficients for every predetermined number of sets of coefficients which belong to the same spatial position in a plurality of subbands which belong to a wavelet transform level of the same hierarchy from the high-frequency subband code sequence following the lowest-frequency subband code sequence; and

inverse wavelet transforming means for performing two-dimensional Haar inverse wavelet transform whenever the coefficient set is decoded, thereby generating the original two-dimensional signal.

51. A decoding device according to claim 50, characterized in that said coefficient decoding means sequentially decodes a predetermined number of coefficient sets at a time in a scan line direction of the two-dimensional signal.

52. A decoding device according to claim 51, characterized in that said coefficient decoding means sequentially decodes the coefficient sets one by one.

53. A decoding device according to claim 52, characterized in that each coefficient comprises a plurality of components, and

said coefficient decoding means decodes each component of a coefficient, and concatenates each component below each coefficient.

54. A decoding device according to claim 52, characterized in that each coefficient comprises a plurality of components, and

said coefficient decoding means decodes each component of a coefficient.

55. (amended) An encoding method characterized by comprising the steps of:

dividing a two-dimensional signal into subbands as a plurality of frequency regions by two-dimensional Haar wavelet transform;

encoding and concatenating a DC component as a lowest-frequency subband, and generating the code sequence of the lowest-frequency subband;

extracting, whenever said two-dimensional Haar wavelet transforming means transforms a predetermined number of two-dimensional signals into a predetermined number of coefficients, sets of AC-component coefficients of coefficients obtained by transform, for every predetermined number of sets of coefficients which belong to the same spatial position;

encoding and concatenating the extracted AC-component coefficient sets, and generating a code sequence of a high-frequency subband; and

outputting the code sequence of the lowest-frequency subband, and sequentially outputting the code sequence of the high-frequency subband.

56. An encoding method according to claim 55, characterized in that in the extracting step, a predetermined number of coefficient sets are sequentially extracted at a time in a scan line direction of the two-dimensional signal.

57. An encoding method according to claim 55, characterized in that in the extracting step, coefficient sets are sequentially extracted one by one.

58. (amended) An encoding method characterized by comprising the steps of:

sequentially extracting $2m \times 2$ (m is an integer: $m \geq 1$) spatially adjacent elements from a two-dimensional signal;

dividing the $2m \times 2$ elements into a plurality of subband coefficient sets by two-dimensional Haar wavelet transform;

encoding and concatenating the AC-component coefficient sets obtained by two-dimensional Haar wavelet transform, and generating a code sequence of a high-frequency subband;

encoding and concatenating a DC component as a lowest-frequency subband, and generating the code sequence of the lowest-frequency subband; and

outputting the code sequence of the lowest-frequency subband, and sequentially outputting the code sequence of the high-frequency subband.

59. (deleted)

60. (deleted)

61. (deleted)

62. (deleted)

63. (deleted)

64. (deleted)

65. (deleted)

66. (deleted)

67. (deleted)

68. (deleted)

69. (deleted)

70. (deleted)

71. (amended) A decoding method characterized by comprising the steps of:

sequentially receiving coefficients of a plurality of subbands obtained by two-dimensional Haar wavelet transform as a code sequence of the subband, from a code sequence of a lowest-frequency subband to a code sequence of a high--frequency subband;

decoding a coefficient of the lowest-frequency subband from a code sequence corresponding to the lowest-frequency subband, and generating a two-dimensional signal of the lowest-frequency subband;

decoding sets of coefficients for every predetermined number of sets of coefficients which belong to the same spatial position in a plurality of subbands which belong to a wavelet transform level of the same hierarchy from a high-frequency subband code sequence following the lowest-frequency subband code sequence; and

performing two-dimensional Haar inverse wavelet transform whenever the coefficient set is decoded, thereby generating the original two-dimensional signal.

72. (amended) A decoding method according to claim 71, characterized in that in the step of decoding the coefficient set, a predetermined

number of coefficient sets are sequentially decoded at a time in a scan line direction of the two-dimensional signal.

73. (amended) A decoding method according to claim 72, characterized in that in the step of decoding the coefficient set, the coefficient sets are sequentially decoded one by one.

74. (amended) An encoding program characterized by causing a computer to execute the steps of:

dividing a two-dimensional signal into subbands as a plurality of frequency regions by two-dimensional Haar wavelet transform;

encoding and concatenating a DC component as a lowest-frequency subband, and generating the code sequence of the lowest-frequency subband;

extracting, whenever said two-dimensional Haar wavelet transforming means transforms a predetermined number of two-dimensional signals into a predetermined number of coefficients, sets of AC-component coefficients of coefficients obtained by transform, for every predetermined number of sets of coefficients which belong to the same spatial position;

encoding and concatenating the extracted AC-component coefficient sets, and generating a code sequence of a high-frequency subband; and

outputting the code sequence of the lowest-frequency subband, and sequentially outputting the code sequence of the high-frequency subband.

75. (amended) An encoding program characterized by causing a computer to execute the steps of:

sequentially extracting $2m \times 2$ (m is an integer: $m \geq 1$) spatially adjacent elements from a two-dimensional signal;

dividing the 2m × 2 elements into a plurality of subband coefficient sets by two-dimensional Haar wavelet transform;

encoding and concatenating the AC-component coefficient sets obtained by two-dimensional Haar wavelet transform, and generating a code sequence of a high-frequency subband;

encoding and concatenating a DC component as a lowest-frequency subband, and generating the code sequence of the lowest-frequency subband; and

outputting the code sequence of the lowest-frequency subband, and sequentially outputting the code sequence of the high-frequency subband.

76. (deleted)

77. (deleted)

78. (deleted)

79. (deleted)

80. (deleted)

81. (deleted)

82. (deleted)

83. (deleted)

84. (amended) A decoding program characterized by causing a computer to execute the steps of:

sequentially receiving coefficients of a plurality of subbands obtained by two-dimensional Haar wavelet transform as a code sequence of the subband, from a code sequence of a lowest-frequency subband to a code sequence of a high--frequency subband;

decoding a coefficient of the lowest-frequency subband from a code sequence corresponding to the lowest-frequency subband, and generating a two-dimensional signal of the lowest-frequency subband;

decoding sets of coefficients for every predetermined number of sets of coefficients which belong to the same spatial position in a plurality of subbands which belong to a wavelet transform level of the same hierarchy from a high-frequency subband code sequence following the lowest-frequency subband code sequence; and

performing two-dimensional Haar inverse wavelet transform whenever the coefficient set is decoded, thereby generating the original two-dimensional signal.

85. (amended) A communication terminal characterized by comprising:

image input means;

communicating means for transmitting and receiving an encoded image signal;

two-dimensional Haar wavelet transforming means for dividing an image signal to be transmitted, which is input by said image input means, into subbands as a plurality of frequency regions;

coefficient extracting means for, whenever said two-dimensional Haar wavelet transforming means transforms a predetermined number of two-dimensional signals into a predetermined number of coefficients, extracting sets of AC-component coefficients of coefficients obtained by transform, for every predetermined number of sets of coefficients which belong to the same spatial position;

coefficient encoding means for encoding and concatenating the extracted AC-component coefficient sets, and generating a code sequence of a high-frequency subband;

initial coefficient encoding means for encoding and concatenating a DC component as a lowest-frequency subband, and generating the code sequence of the lowest-frequency subband;

code output means for outputting the code sequence of the lowest-frequency subband to said communication means, and sequentially outputting the code sequence of the high-frequency subband generated by said coefficient encoding means to said communication means;

initial coefficient decoding means for decoding a coefficient of the lowest-frequency subband from a code sequence corresponding to the lowest-frequency subband of the received image signal, and generating an image signal of the lowest-frequency subband;

coefficient decoding means for decoding sets of AC-component coefficients for every predetermined number of sets of coefficients which belong to the same spatial position in a plurality of subbands which belong to a wavelet transform level of the same hierarchy from the high-frequency subband code sequence following the lowest-frequency subband code sequence;

inverse wavelet transforming means for performing two-dimensional Haar inverse wavelet transform whenever the coefficient set is decoded, thereby generating the original received image signal; and

image display means for displaying a received image on the basis of the received image signal.

ABSTRACT

An image is divided into subbands by wavelet transform using the Haar function as the base, and the lowest-frequency LL subband is entirely encoded. LH, HL, and HH subband coefficients which belong to the wavelet decomposition level of each hierarchy are then encoded such that coefficients at the same spatial position are encoded at once. The decoding side first decompresses the lowest-frequency LL subband, and then decodes sets of the LH, HL, and HH coefficients at the same spatial position in the subband of each wavelet decomposition level one by one. The decoding side immediately performs inverse wavelet transform by using the coefficient values, thereby obtaining the LL coefficient value of the next wavelet decomposition level. This makes it possible to sufficiently increase the processing speed even when the wavelet encoding/decoding is performed using a sequential CPU.